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(54) Load detector for elevator car

(57) A load detector for an elevator having a cage moving up and down in a shaft for transporting passengers and a cable hanging the cage, including a relative position detector configured to detect a relative position of the cage against the shaft; and a calculator configured to calculate a change of the relative position between the position of the cage just after landing at a floor and the position of the cage just before leaving the floor, and a load of the cage on the basis of the change of the relative position caused by an expansion and contraction of the cable.

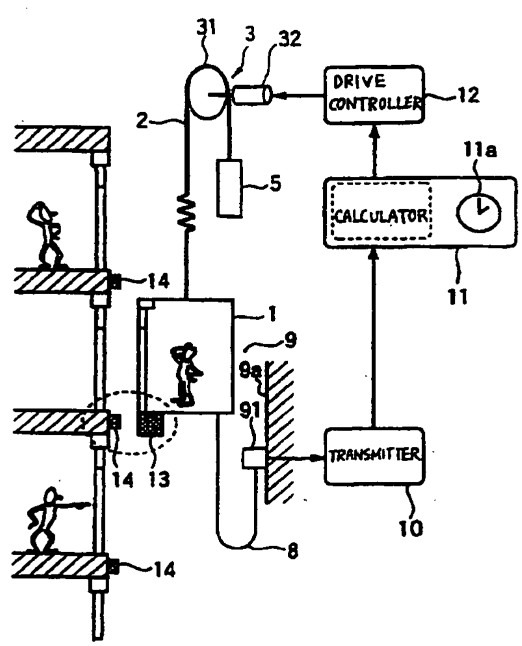

FIG. 3

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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a load detector for an elevator cage.

DESCRIPTION OF THE BACKGROUND

[0002] An ordinary traction type elevator is composed as shown in FIG. 1 and FIG. 2.

[0003] In FIG. 1, one terminal of a cable 2 is connected to a cage 1 and the other terminal of the cable 2 is connected to a counter weight via a sheave 31 of a hoisting machine 3 and deflector sheave 4. The hoisting machine is composed of the sheave 31 and a motor 32. The sheave 31 is driven by the motor 32, and the cable 2 is driven by the traction between the sheave 31 and the cable 2. Eventually, the cage 1 is moved up and down via the cable 2.

[0004] As shown in enlarged FIG. 2, the cage 1 moves up and down along guide rails 7 by means of guide devices 6 attached to the cage 1. The cage 1 is composed of a cage frame 1A including a crosshead 1Aa, an upright 1Ab and a plank 1Ac, and a cab 1B mounted in the cage frame 1A. That is, construction of the cage 1 is in effect doubled by providing the cage frame 1A around the cab 1B, and the cab 1B is supported by vibration-proof materials 1C such as a rubber. The vibration-proof materials 1C reduce vibration transfer from the cage frame 1A to the cab 1B and improve passenger comfort during travel of the cage 1.

[0005] Further, a deformation detector 1D is installed between the cage frame 1A and the cab 1B. The vibration-proof materials 1C is pressed by the load of the cab 1B, and the amount of the deformation of the vibration-proof materials 1C is detected by the deformation detector 1D. The amount of the deformation is transmitted to a calculator 11 in an elevator control panel via a transmitting cable 8, a connector box 91 attached on a shaft wall 9a of a shaft 9, and a transmitter 10. The calculator 11 calculates the load of the cab 1B or the load of passengers on the basis of the amount of the deformation from the deformation detector 1D.

[0006] The calculator 11 also calculates a necessary torque to drive the motor 32 so as to move the cage 1 smoothly at the start time, and outputs the torque signal to a drive controller 12. Accordingly, even if the cage 1 is filled with many passengers, the cage 1 does not move down suddenly at the start time when a brake is off. On the other hand, even if the cage 1 has no passengers, the cage 1 does not move up suddenly at the start time. That is, the drive controller 12 applies a necessary torque to the motor 32 before the brake is off so as to move the cage 1 smoothly at the start time.

[0007] In the above described traction type elevator, both the cage frame 1A and the cab 1B need a proper strength. It is not easy for the cage 1 to meet both the requirements of the proper strength and the capacity of the cab 1B.

[0008] As the efficiency of the hoisting machine 3 improves, the vibration of the cage 1 has been reduced. Therefore, all cages are not required to be constructed in double in order to improve comfort of a ride in the cab 1B.

[0009] But if the cage 1 has a single construction, that is to say, the cab 1B is integrated with the cage frame 1A, the deformation detector 1D can not be installed between the cage frame 1A and the cab 1B. As a result, since a load of the cab 1B can not be detected properly, the elevator has difficulty in controlling the torque applied to the motor 32 at the start time in accordance with change in the load.

SUMMARY OF THE INVENTION

[0010] Accordingly, one object of the invention is to provide a load detector for an elevator which can detect the passenger load, even if a cab is integrated with a cage frame.

[0011] This and other objects are achieved by providing a new and improved load detector for an elevator having a cage moving up and down in a shaft for transporting passengers, and a cable supporting the cage, including a relative position detector configured to detect a relative position of the cage against the shaft; and a calculator configured to calculate a change of the relative position between the position of the cage just after landing at a floor and the position of the cage just before leaving the floor, and a load of the cage on the basis of the change of the relative position caused by an expansion and contraction of the cable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic overview of a conventional traction type elevator.
FIG. 2 is a side view of a conventional traction type elevator in FIG. 1.
FIG. 3 is a schematic overview of a load detector for an elevator cage of a first embodiment of the present invention.
FIG. 4 is a side view of an optical position sensor shown in FIG. 3.
FIG. 5 is a side view of a load detector for an elevator of a second embodiment of the present invention.

FIG. 6 is a side view of a load detector for an elevator of a third embodiment of the present invention.

FIG. 7 is a side view of a load detector for an elevator of a fourth embodiment of the present invention.

FIG. 8 is a side view of a load detector for an elevator of a fifth embodiment of the present invention.

FIG. 9 is a sectional view of a brake showing a load detector for an elevator of a sixth embodiment of the present invention.

FIG. 10 is a sectional view of a brake showing a load detector for an elevator of a sixth embodiment of the present invention.

FIG. 11 is a schematic illustration of an elevator having hanging sheaves.

FIG. 12 is a partial view of hanging sheaves shown in FIG. 11.

FIG. 13 is a sectional view of a hanging sheave showing a load detector for an elevator of a seventh embodiment of the present invention.

FIG. 14 is a sectional view of a hanging sheave showing a load detector for an elevator of an eighth embodiment of the present invention.

FIG. 15 is a side view of a sheave showing a load detector for an elevator of a ninth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views and more particularly FIG. 3 thereof, FIG. 3 shows a load detector for an elevator cage of a first embodiment of the present invention.

[0014] In FIG. 3, a cage 1 for passengers moves up and down by the movement of a cable 2. The cage 1 has a optical position sensor 13. Reflecting plates 14 are attached on a shaft 9 near each floor level and arranged to face the optical position sensor 13 at the time the cage 1 lands at the floor. Thus, a relative position detector is composed of the optical position sensor 13 and the reflecting plate 14. The position sensor 13, as shown in FIG. 4, is composed of a light source 132 in a box 131 for irradiating a light with a predetermined wavelength toward the reflecting plates 14, a lens 134 in the box 131 for gathering a reflected light from one of the reflecting plates 14, and photoconductive cells such as PSD (Position Sensitive Device) elements 133 arranged in the moving direction of the cage. Each of the PSD elements 133 transforms a gathered light from the lens 134 into a voltage signal, and the PSD elements 133 are arranged to output respective different voltage signals in accordance with the position of the cage 1.

[0015] If the cage 1 shifts up or down at the landing floor, the voltages produced by the PSD elements 133 of optical position sensor 13 also shift up or down. In other words, a relative position of the cage 1 against the reflecting plate 14 on the shaft 9 changes and the voltage signals from the PSD elements 133 also change on the basis of the relative position of the cage 1 against the reflecting plate 14. The voltage signals are transmitted to a filter 135 in order to extract and output a constituent signal corresponding to the light with the predetermined wavelength. That is, the filter 135 eliminates noise from the voltage signals. The constituent signal is transmitted to a transmitter 10 via a cable 8 and a connector box 91 on a shaft wall 9a.

[0016] A field of vision of the lens 134 is set greater than a field of reflected light from the reflecting plate 14. Reflected light from the shaft wall 9a except the reflected light from the reflecting plate 14 is scattered and is not detected by the PSD elements 133 effectively.

[0017] When the cage 1 lands on a floor level, the voltage signals from the PSD elements are outputted corresponding to the vertical position of the cage 1 and transmitted to a calculator 11 via the transmitter 10. The calculator 11 has a timer 11a and manages the voltage signals in order of the input time. The calculator 11 calculates a passed time after closing a cage door, if there is no call, i.e., either a destination call or a hall call. The destination call is a call by which passengers order the destination in the cage 1, the hall call is a call by which passengers call the cage 1 to a floor. If the passed time exceeds a predetermined time and the cage 1 does not move during the passed time, the calculator 11 resets a load value to zero on the assumption that there is no passenger in the cage 1.

[0018] If a destination call is made, the cage 1 goes up or down and lands at the destination floor. The operation of detecting a load of cage 1 is as follows.

[0019] First, as the cage 1 approaches to land at a floor level, the optical position sensor 13 detects the reflecting plate 14 of the destination floor. Before the cage door opens, the relative position Yb of the cage 1 against the reflecting plate 14 is detected by the optical position sensor 13. At this time, the cage 1 stops at the landing floor, because the sheave 31 is locked by a brake device (not shown). However, since the cable 2 itself has elasticity, the cable 2 expands and contracts corresponding to a load change of the cage 1. As a result, the vertical position of the cage 1 changes, even if the cage 1 lands and stops on the floor. Consequently, when passengers finish getting on and off, the vertical position of the cage 1 could change corresponding to the load change of the cage 1.

[0020] Therefore, after passengers get on and off and the cage door closes, the optical position sensor 13 detects the relative position Ya of the cage 1 against the reflecting plate 14.

[0021] The calculator 11 then calculates the current load Mn of the cage 1 on the basis of the relative positions Ya and Yb, an elastic coefficient k of the cable 2, and the previous load Mo of the cage 1, and the current load Mn is calculated as follows.

$$Mn = Mo + k \times (Yb - Ya)$$

[0022] The elastic coefficient k can be changed corresponding to the vertical position of the cage 1. Because the length of the cable 2 between the sheave 31 and the cage 1 changes corresponding to the vertical position of the cage 1. Therefore, the elastic coefficient k is applied corresponding to location of the cage 1.

[0023] The calculator 11 calculates a necessary torque to drive the motor 32 so as to start the cage 1 smoothly on the basis of the load Mn, and outputs the torque signal to a drive controller 12.

[0024] According to the first embodiment, even if the cage 1 has a "single" construction, that is to say, the cab 1B is integrated with the cage frame 1A in FIG. 1, a load of the cage 1 can be calculated on the basis of the difference of the relative position of the cage 1 against the shaft wall 9a, between a vertical position of the cage 1 just after landing at a floor and a vertical position of the cage 1 just before leaving the floor. Further, if the no call time exceeds a predetermined time and the cage 1 does not move for the no call time, the calculator 11 resets the load value to zero indicating that there is no passenger in the cage 1. Therefore, a cumulative error of a load of the cage 1 can be automatically adjusted. Furthermore, since the optical position sensor 13 detects the relative position of the cage 1 against the reflecting plate 14, the load detector can be used as a landing position detector of the cage 1. Moreover, since the optical position sensor 13 detects the relative position of the cage 1 against the reflecting plate 14 without mechanical contact and the filter 135 eliminates noise due to other light sources, the precision of the load detector can be improved.

[0025] In the first embodiment, the optical position sensor 13 and the reflecting plate 14 can be changed. A camera having an image sensor which can recognize light and shade can be substituted for the position sensor 13 and a plate having a geometric or other pattern can be substituted for reflecting plate. The camera can then be provided with an image processor (not shown) to recognize an image of the geometric or other pattern, or a portion of this pattern, picked up by the camera, and output different signals corresponding to the position of the cage 1.

[0026] FIG. 5 shows a load detector of the second embodiment of the present invention.

[0027] In the following description, only components different from the components explained in the related art in FIG. 1 are described.

[0028] In this embodiment, a potential meter 15 is attached to the bottom of the cage 1. The potential meter 15 is composed of a slide shaft 151 moving in the axial direction of a cylinder 152. A roller 153 is attached to the end of the slide shaft 151. The roller 153 rotates in the moving direction of the cage 1. A spring 154 is inserted between the roller 153 and the cylinder 152 so that the roller 153 is always forced toward the shaft wall 9a.

[0029] Slopes 16 are secured on the shaft wall 9a near all floor levels. Each slope 16 has an inclined plane 16a as shown in FIG. 5. The roller 153 is to pass the floor level contacting the inclined plane 16a.

[0030] When the cage 1 lands on an exact floor level, that is, a relative position of the cage 1 against a floor level is nearly zero, the roller 153 is to be positioned at the middle of the slope 16.

[0031] Accordingly, since the slide shaft 151 is forced toward the shaft wall 9a by the spring 154, if the cage 1 moves up and down, the roller 153 rolls on the slope 16, and the slide shaft 151 slides in axial direction of the cylinder 152. As a result, the potential meter 15 outputs voltage signals corresponding to a position of the slide shaft 151, and the voltage signals are transmitted to the transmitter 10 via the transmitting cable 8.

[0032] Thus, when the cage 1 stops at the floor, the vertical position change of the cage 1 is read by a horizontal position change of the roller 153.

[0033] If a destination call is made, the cage 1 goes up or down and lands at the destination floor. The operation of detecting a load of cage 1 is as follows.

[0034] First, as the cage 1 approaches to land at a floor level, the roller 153 contacts the slope 16. Before the cage door opens, the relative position Yb of the cage 1 against the shaft wall 9a is detected by the potential meter 15. At this time, the cage 1 stops at the landing floor, because the sheave 31 is locked by a brake device (not shown). However, since the cable 2 itself has elasticity, the cable 2 expands and contracts corresponding to a load change of the cage 1. As a result, the vertical position of the cage 1 changes, even if the cage 1 lands and stops at the floor. Consequently, when passengers finish getting on and off, the vertical position of the cage 1 could change corresponding to a load change of the cage 1.

[0035] Therefore, after passengers getting on and off and closing the cage door, the potential meter 15 detects the relative position Ya of the cage 1 against the shaft wall 9a.

[0036] The calculator 11 then calculates the current load Mn of the cage 1 on the basis of the relative positions Ya and Yb, an elastic coefficient k of the cable 2, and the previous load Mo of the cage 1 in the same way as the first embodiment.

[0037] According to the second embodiment, similarly, even if the cage 1 has the "single" construction, that is to say, the cab 1B is integrated with the cage frame 1A in FIG. 1, a load of the cage 1 can be calculated on the basis of the difference of the relative position of the cage 1 against the shaft wall 9a, between the vertical position of the cage 1 just after landing a floor and the vertical position of the cage 1 just before leaving the floor.

[0038] FIG. 6 shows a load detector for an elevator cage of a third embodiment of the present invention.

[0039] In the following description, only components different from the components explained in the related

art in FIG. 1 are described.

[0040] In FIG. 6, an optical position sensor 17 is attached to the bottom of the cage 1. Slopes 18 are secured on the shaft wall 9a near all floor levels. Each slope 18 has a number of tiers and a triangular cross section as shown in FIG. 6. The horizontal width of each tier is different from another. That is, the horizontal width of the tiers are formed to be gradually changed in the moving direction of the cage 1. The optical position sensor 17 detects a distance from the cage 1 to the tiers of slopes 18. The optical position sensor 17 is composed of a pulse laser device and a distance detector. The pulse laser device irradiates a pulse laser light toward the tiers of slopes 18. The pulse laser light has a relatively narrow beam width, that is, the pulse laser light is not easily scattered. The distance detector detects a reflected laser light from the tiers of the slopes 18 and calculates a distance from the cage 1 to the tiers of the slopes 18.

[0041] Accordingly, the optical position sensor 17 outputs voltage signals corresponding to a distance from the cage 1 to the tiers of the slopes 18, and the voltage signals are transmitted to the transmitter 10 via the transmitting cable 8.

[0042] Thus, when the cage 1 stops at the floor, the vertical position change of the cage 1 is read by a change of a distance from the cage 1 to the tiers of the slopes 18.

[0043] According to the third embodiment, since a vertical position change of the cage 1 is detected by the optical position sensor 17, a load of the cage 1 can be detected in the same way as the second embodiment. Further, since the load of the cage 1 is detected by the optical position sensor 17 with no contact with the slopes 18, error due to frictional wear can be avoided and a durable detector can be obtained.

[0044] FIG. 7 shows a load detector for an elevator cage of the fourth embodiment of the present invention, in which the load detector detects a load of the cage by detecting an angle change of a roller rolling on a guide rail in accordance with the movement of the cage 1.

[0045] That is, a disk roller 192 is secured to the upper base 191 of the cage 1 and rolls on a guide rail 7 in accordance with the movement of the cage 1. All angle detector 193 is arranged to an axis of the disk roller 192. The angle detector 193 is attached to one end of a lever 194, the other end of the lever 194 is pivotably secured to a fulcrum 194a of the base 191. A pole 195 stands on the base and passes through the lever 194. A spring 196 is arranged between one end of the pole 195 and the lever 194 so that the spring 196 pushes the lever 194 toward the guide rail 7 at any time.

[0046] Accordingly, the disk roller 192 is pushed with the righting moment of the spring 196 and rolls on the guide rail 7. As the disk roller 192 rotates according to the movement of the cage 1, the angle detector 193 rotates as well. As a result, an angle change of the disk roller 192 is detected by the angle detector 193. Then, the output signal of the angle detector 193 is transmitted to the calculator 11 via the transmitting cable 8 and the transmitter 10.

[0047] The calculator 193 calculates a vertical position change of the cage 1 on the basis of the radius of the disk roller 192 and the angle change of the disk roller 192.

[0048] Thus, when the cage 1 stops at the floor, a vertical position change of the cage 1 from the time the cage door is opened until the time of closing is read by an angle change of the disk roller 192.

[0049] According to the fourth embodiment, a load of the cage 1 can be detected in the same way as the second embodiment. Further, since the calculator 193 is provided with an angular information from the angle detector 193 in accordance with a speed of the cage 1, the calculator 193 can calculate a speed of the cage 1 on the basis of time-differentiating the angular information. If a speed of the motor 32 is controlled by comparing the speed of the cage 1 with the predetermined velocity pattern, the hoisting machine 3 can be extremely precise.

[0050] FIG. 8 shows a load detector for an elevator cage of the fifth embodiment of the present invention, in which the load detector has two position sensors such as the potential meter 15 in FIG. 5, attached to the bottom of the cage 1, so as to correct an error caused by an inclination of the cage 1 and to calculate a load of the cage 1 precisely.

[0051] That is, two potential meters 15A and 15B are attached to the bottom edges of the cage 1 symmetrically.

[0052] Rollers 153A and 153B are respectively arranged to face toward the shaft wall 9a, and slide shafts 151A and 151B are respectively arranged to the same horizontal plane. Further, slopes 16A and 16B are secured on the shaft wall 9a near all floor levels. Each slope 16 has the same inclined plane as the FIG. 5. Output signals of the potential meters 15A and 15B are transmitted to the transmitter 10 via a calculator 20.

[0053] Thus, the potential meters 15A and 15B respectively detect horizontal changes of the slide shafts 151A and 151B and respectively output voltage signals. The calculator 20 averages these voltage signals and transmits an averages signal to the transmitter 10.

[0054] According to the fifth embodiment, two potential meters 15A and 15B are attached to the bottom edges of the cage 1 symmetrically, and output signals of the potential meters 15A and 15B are averages. Therefore, even if the cage 1 inclines due to a biased load in the cage 1, a vertical position change of the cage 1 can be detected properly. As a result, the load detector can be precise.

[0055] In the fifth embodiment, two potential meters 15A and 15B are applied to the position sensor. Obviously, the optical position sensor 17 in FIG. 6 can be substituted for the potential meters 15A and 15B.

[0056] FIG. 9 and FIG. 10 are sectional views of a brake showing a load detector for an elevator cage of the sixth embodiment of the present invention.

[0057] In the following description, only components different from the components explained in the related art in FIG. 1 are described.

[0058] In FIG. 9, a brake 33 is secured to a rotary shaft 31a between the sheave 31 and the motor 32 (not shown in FIG. 9). A sheave gear 31b having teeth on the surface is secured to the rotary shaft 31a in a housing 33a of the brake 33. A disk gear 33b meshes with the sheave gear 31b slidably in an axis direction. A brake disk 33c is secured to the surface of the disk gear 33b. Further, a ring-shaped brake shoe 33d is attached to an inside wall of the housing 33a of the brake 33. A ring-shaped elastic ring 33e lies between the brake shoe 33d and the inside wall of the housing 33a. A brake shoe 33g is attached to the other inside wall of the housing 33a via springs 33f. Electromagnets 33h are arranged between the brake shoe 33g and the inside wall of the housing 33a. Furthermore, a strain gage 33i is attached on the surface of the elastic ring 33e. Bearings 33j are secured between the housing 33a and the rotary shaft 31a. All output signal of the strain gage 33i is transmitted to the calculator 11.

[0059] The operation of the above composed brake 33 is described as follows.

[0060] At the time a proper current is applied to electromagnets 33h, the springs 33f are contracted by an attraction force of the electromagnets 33h, and the brake shoe 33g shifts away from the brake disk 33c as shown in FIG. 9. Eventually, the brake disk 33c rotates freely between the brake shoes 33g and 33d, and the sheave 31 is driven by the motor 32 without brake resistance.

[0061] On the contrary, at the time a current is not applied to electromagnets 33h, the springs 33f expands and pushes the brake shoe 33g toward the brake disk 33c as shown in FIG. 10. Eventually, the brake disk 33c is caught between the brake shoes 33g and 33d, and the sheave 31 is locked.

[0062] A load of the cage 1 is applied to the rotary shaft 31a via the sheave 31. If a weight unbalance between the cage 1 and the counter weight 5 occurs due to a load change of the cage 1, a torsion force is applied to the sheave 31 corresponding to the weight imbalance, and the surface of the elastic ring 33e is pushed by the brake disk 33c connected to the sheave 31. As a result, the strain gage 33i outputs a voltage signal corresponding to a torsion force applied to the elastic ring 33e. The voltage signal is transmitted to the calculator 11. The calculator 11 calculates a torsion torque change of the sheave 31 on the basis of the voltage signal from the strain gage 33i, and calculates a load change of the cage 1 on the basis of the torsion torque.

[0063] According to the sixth embodiment, a load change of the cage 1 is calculated by calculating a torsion torque change of the sheave 31 locked by the brake 33. As a result, a load of the cage 1 can be obtained on the basis of a load change of the cage 1.

[0064] FIG. 11 is a side view of a traction type elevator having hanging sheaves.

[0065] In the following description, only components different from the components explained in the related art in FIG. 1 are described.

[0066] In this type of elevator, the cage 1 has a "single" construction, that is to say, the cab is integrated with the cage frame. One end of the cable 2 is secured to a hitch 2B at an upper portion of the shaft 9. The other end of the cable 2 is secured to a hitch 2A via the counter weight 5, the hoisting machine 3, and hanging sheaves 1C of the cage 1. The cable 2 is driven by the hoisting machine 3, and the cage 1 and the counter weight 5 relatively move up and down.

[0067] In the above composed elevator, as shown in FIG. 12, a tension F1 corresponding to a load of the cage 1 is applied to a shaft 1Ca of the hanging sheave 1C. A change of the tension F1 corresponds to a load change of the cage 1. Consequently, a change of a force F2 applied to the shaft 1Ca corresponds to a load change of the cage 1.

[0068] FIG. 13 is a sectional view of a hanging sheave showing a load detector for an elevator cage of a seventh embodiment of the present invention, in which the load detector detects a change of the force F2 applied to the shaft 1Ca by means of a strain gage .

[0069] That is, as shown in FIG. 13, the shaft 1Ca (only one is shown) is rotatably secured to the cage 1 via a bearing 1Cc, and the shaft 1Ca is supported by support members 1Cd on the cage 1. Strain gages 1Ce are built in the shaft 1Ca near the bearing 1Cc so as to detect a strain caused by a force F2 applied to the rotary shaft via the bearing 1Cc. Output signals of the strain gages 1Ce are transmitted to the calculator 11 via the transmitting cable 8 shown in FIG. 1. The calculator 11 calculates a load change of the cage 1 on the basis of a change of a force F2 applied to the shaft 1Ca, and then calculates a load of the cage 1. Finally, the calculator 11 calculates a necessary torque to drive the motor 32 so as to start the cage 1 smoothly on the basis of the load of the cage 1.

[0070] FIG. 14 is a sectional view of a rotary shaft showing a load detector for an elevator cage of an eighth embodiment of the present invention.

[0071] In FIG. 13, a load of the cage 1 is calculated on the basis of a force F2 applied to the shaft 1Ca and detected by the strain gages 1Ce built in the shaft 1Ca, while in FIG. 14, a load of the cage 1 is calculated on the basis of a strain of elastic members 1Cf lying between the shaft 1Ca and the cage 1 instead of the support members 1Cd in FIG. 13.

[0072] That is, as shown in FIG. 14, a force F2 is applied to the cage 1 via the bearing 1Cc, the shaft 1Ca and the elastic members 1Cf. The elastic members 1Cf deforms by a load change of the cage 1. The deforma-

tion of the elastic members 1Cf is detected by a potential meter 1Cg, i.e., a differential transformer which transforms displacement into electric resistance, attached in parallel to one of the elastic members 1Cf. All output signal of the potential meter 1Cg is transmitted to the calculator 11 via the transmitting cable 8. The calculator 11 calculates a load change of the cage 1 on the basis of a change of a force F2 applied to the shaft 1Ca, and then calculates a load of the cage 1. Finally, the calculator 11 calculates a necessary torque to drive the motor 32 so as to start the cage 1 smoothly on the basis of the load of the cage 1.

[0073] According to the eighth embodiment, since a load detector is installed at the hanging sheave 1C, a load of the cage 1 is detected precisely.

[0074] FIG. 15 is a side view of a sheave showing a load detector for an elevator cage of a ninth embodiment of the present invention.

[0075] In FIG. 15, the hoisting machine 3 is arranged on a shaft ceiling wall 9b via two elastic members 31c. A potential meter 31d is attached in parallel to one of the elastic members 31c. The potential meter 31d outputs a voltage signal corresponding to a deformation of the elastic member 31c. An output signal of the potential meter 31d is transmitted to the calculator 11 via the transmitting cable 8.

[0076] A force F3 applied to the rotary shaft 31a of the sheave 31 is based on the sum of a load of the cage 1, a load of the counter weight, a load of the cable 2 and a load of the hoisting machine 3. Above all, the load of the cage 1 is the only item to be changeable.

[0077] Thus, a load change of the cage 1 is calculated on the basis of a deformation of the elastic member 31c detected by the potential meter 31d. The calculator 11 calculates a load of the cage 1 on the basis of the load change of the cage 1. Finally, the calculator 11 calculates a necessary torque to drive the motor 32 so as to start the cage 1 smoothly on the basis of the load of the cage 1.

[0078] Various modifications and variations are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

Claims

1. A load detector for an elevator having a cage moving up and down in a shaft for transporting passengers and a cable hanging said cage, comprising:

   a relative position detector configured to detect a relative position of said cage against said shaft; and
   a calculator configured to calculate a change of said relative position between the position of said cage just after landing at a floor and the position of said cage just before leaving said floor, and a load of said cage on the basis of said change caused by an expansion and contraction of said cable.

2. The load detector for an elevator as recited in claim 1, wherein:

   said relative position detector comprises a plurality of reflecting plates attached on said shaft near floor levels, a light source attached to said cage for irradiating a light with a predetermined wavelength toward said reflecting plates, a lens attached to said cage for gathering reflected light from said reflecting plates, and a plurality of photoconductive cells arranged in a moving direction of said cage so as to output respective voltage signals on the basis of gathered light from said lens; and
   said calculator is configured to calculate said relative position on the basis of said voltage signals from said photoconductive cells.

3. The load detector for an elevator as recited in claim 1, wherein:

   said relative position detector comprises a plurality of slopes attached on said shaft near floor levels along a moving direction of said cage, said slopes having inclined planes with triangular cross sections, a roller attached to said cage and rolling on said inclined planes, a slide shaft connected to said roller for guiding in a horizontal direction, and an elastic member for pushing said roller toward said slopes elastically; and
   said calculator is configured to calculate said relative position on the basis of the position of said slide shaft.

4. The load detector for an elevator as recited in claim 1, wherein:

   said relative position detector comprises a plurality of slopes attached on said shaft near floor levels along the moving direction of said cage, said slopes having a plurality of tiers, a laser device attached to said cage and configured to irradiate a laser light toward said tiers, and a distance detector attached to said cage and configured to receive a reflected laser light from said tiers and to detect a distance to said tiers of said slopes; and
   said calculator is configured to calculate said relative position on the basis of said distance to said tiers.

5. The load detector for an elevator as recited in claim 1, wherein:

said calculator is configured to reset a load value as a no load of said cage in case a time of no destination call being made exceeds a predetermined time after said cage stops.

6. A load detector for an elevator having a cage moving up and down in a shaft for transporting passengers and a rope hanging said cage, comprising:

a roller attached to said cage;
a guide rail arranged in said shaft for rolling and guiding said roller in accordance with the movement of said cage;
an angle detector for detecting an angle change of said roller; and
a calculator configured to calculate a vertical position change of said cage from the time said cage door is opened until the time of closing on the basis of said angle change of said roller, and a load of said cage on the basis of said vertical position change.

7. A load detector for an elevator having a cable placed around a sheave driven by a motor, said cable hanging a weight and a cage moving up and down in a shaft for transporting passengers, comprising:

a brake having a brake disk secured to a rotary shaft of said motor, and a brake shoe for pressing said brake disk toward an elastic member and stopping the revolution of said sheave;
a strain detector attached to said elastic member and configured to detect a torsional strain of said brake disk caused by an unbalance in weight between said cage and said weight; and
a calculator configured to calculate a change of said torsional strain between a torsional strain just after said cage lands at a floor and a torsional strain just before said cage leaves said floor, and a load of said cage on the basis of said change of said torsional strain.

8. A load detector for an elevator having a cable placed around a sheave driven by a motor, said cable hanging a cage through a hanging sheave attached to said cage moving up and down in a shaft for transporting passengers, comprising:

a strain detector configured to detect a strain of a rotary shaft of said sheave; and
a calculator configured to calculate a change of a strain of said sheave just after said cage lands at a floor and a strain of said sheave just before said cage leaves said floor, and a load of said cage on the basis of said change of said strain.

9. A load detector for an elevator having a cable placed around a sheave driven by a motor, said cable hanging a cage through a hanging sheave attached to said cage moving up and down in a shaft for transporting passengers, comprising:

a strain detector configured to detect a strain of a shaft of said hanging sheave; and
a calculator configured to calculate a change of a strain of said hanging sheave just after said cage lands at a floor and a strain of said hanging sheave just before said cage leaves said floor, and a load of said cage on the basis of said change of said strain.

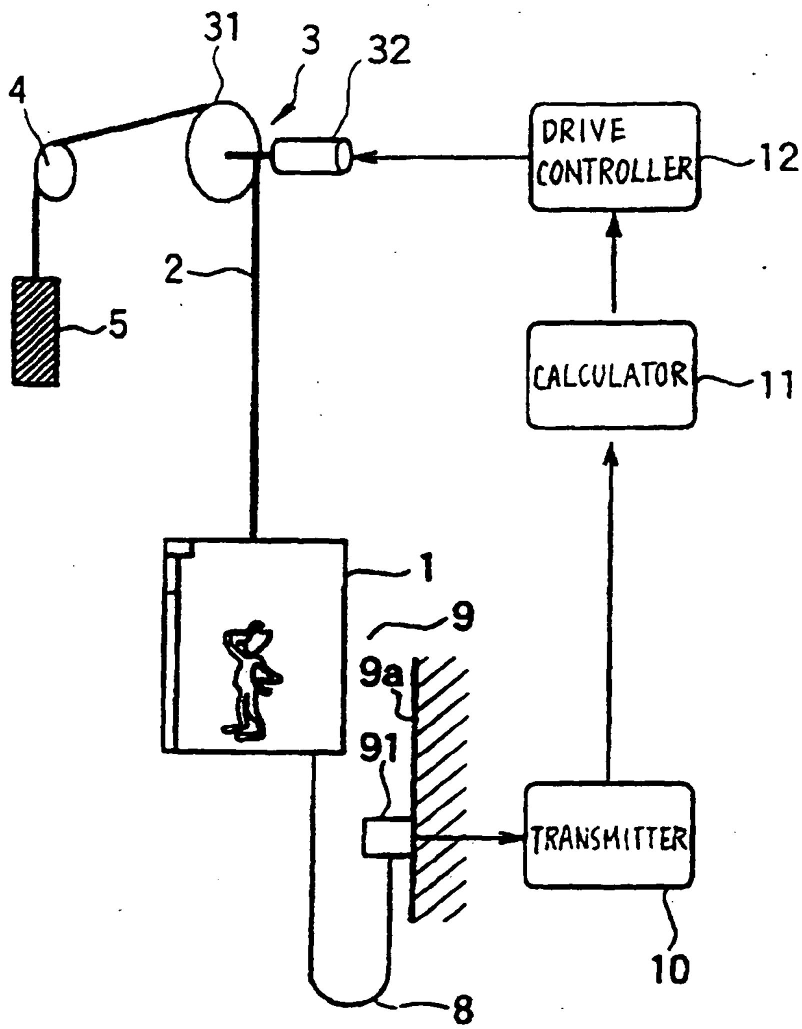

FIG. 1 (PRIOR ART)

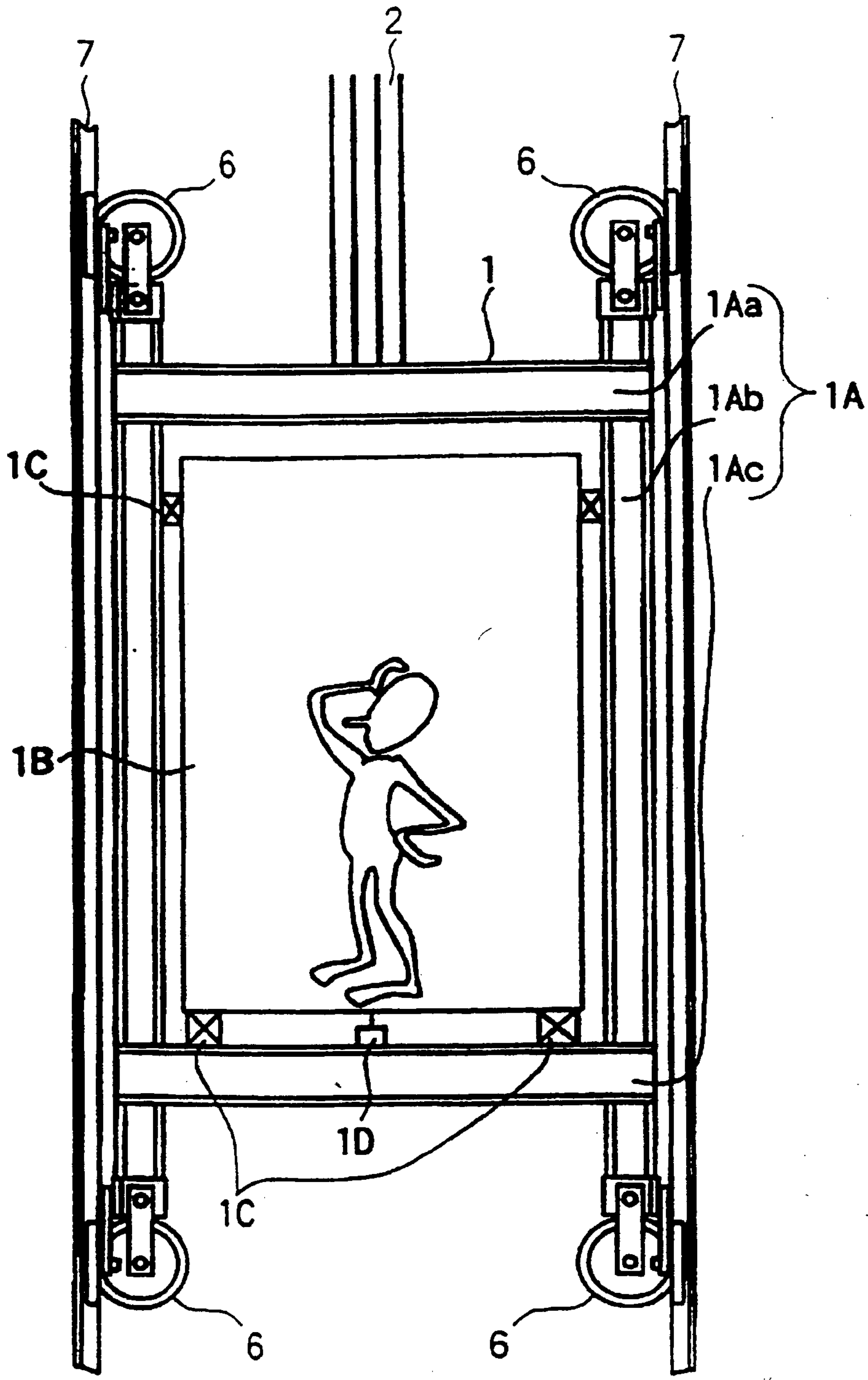

FIG. 2 (PRIOR ART)

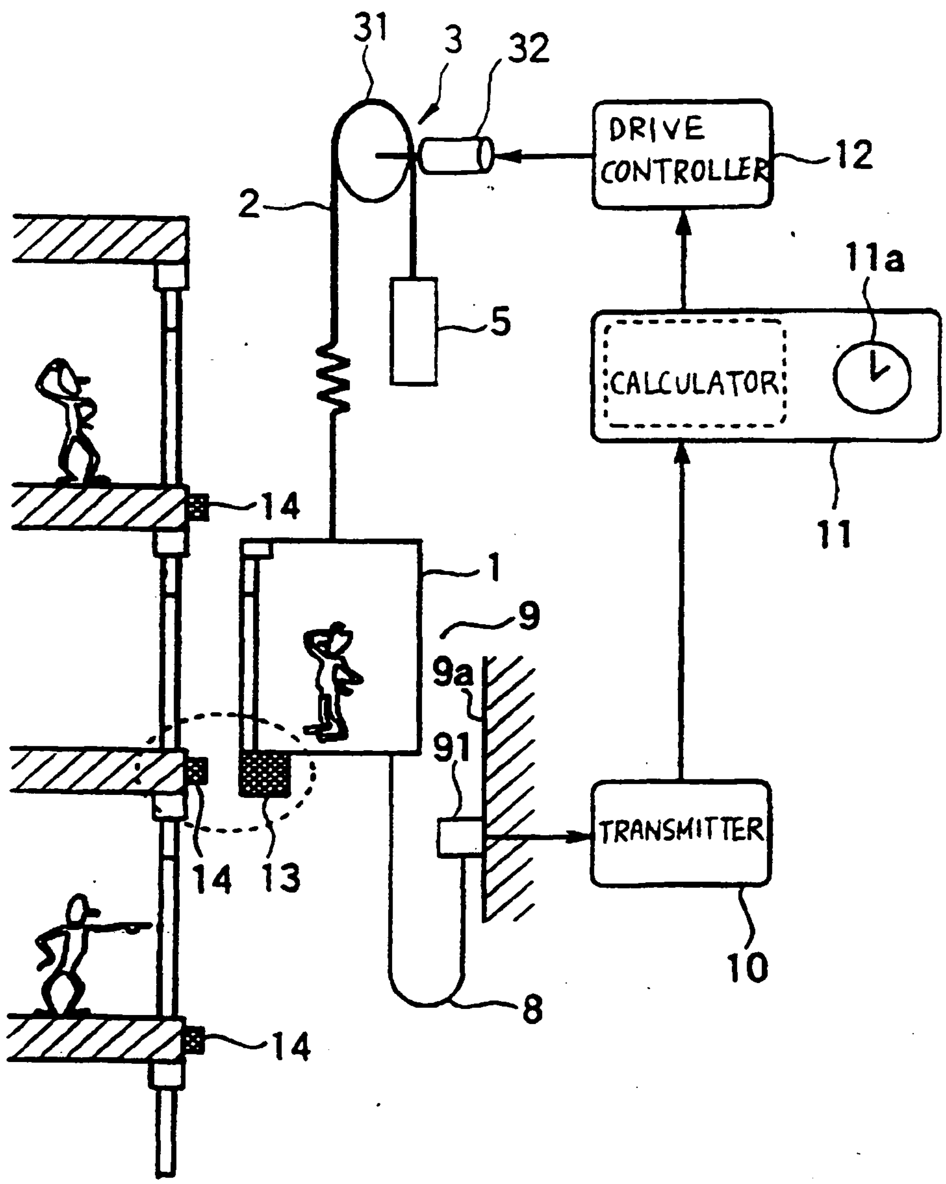
31
3
32
DRIVE CONTROLLER
12
2
11a
5
CALCULATOR
14
11
1
9
9a
91
TRANSMITTER
14
13
10
8
14

FIG. 3

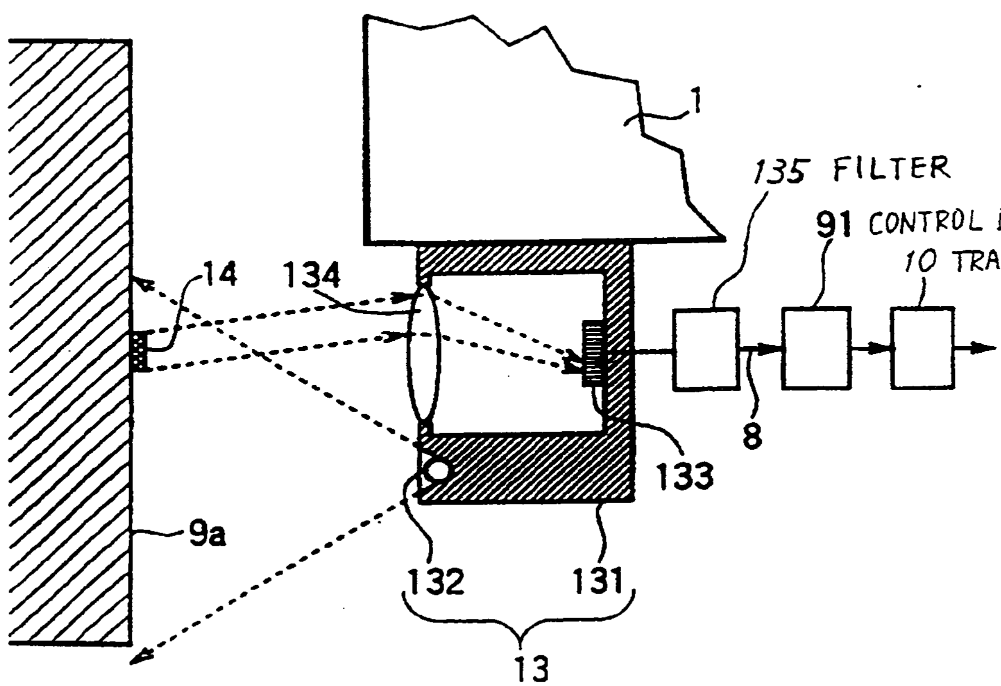
1
135 FILTER
91 CONTROL BOX
10 TRANSMITTER
14
134
133
8
9a
132
131
13

FIG. 4

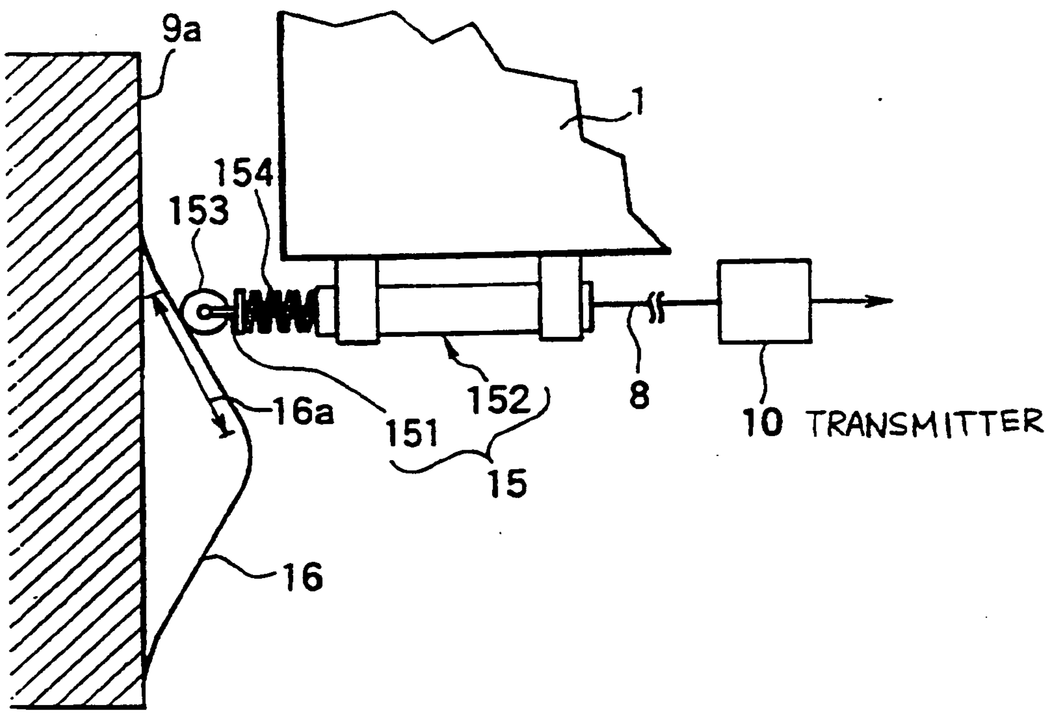

FIG. 5

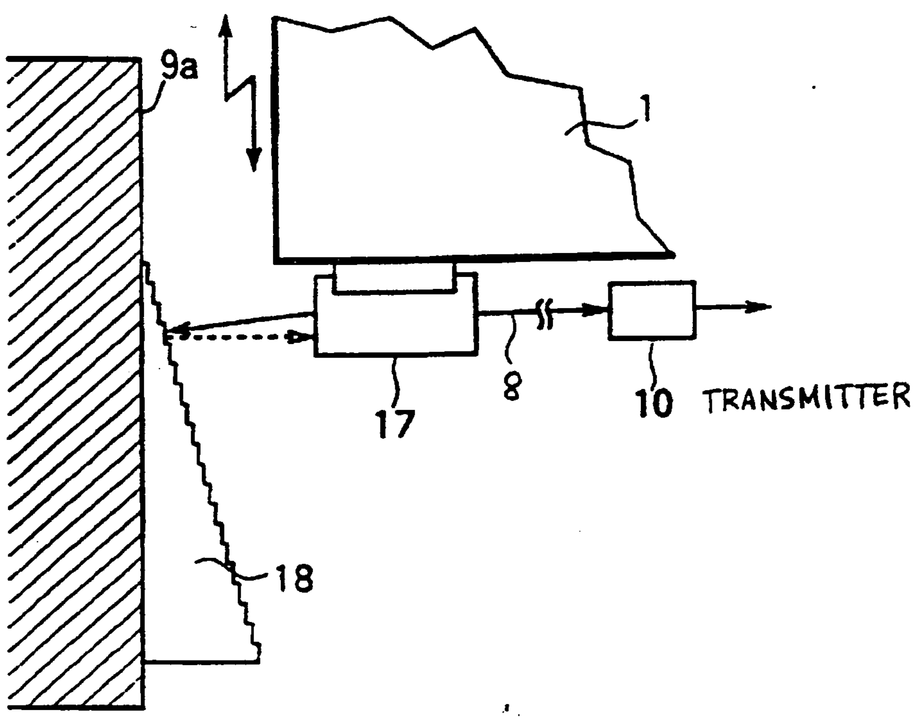

FIG. 6

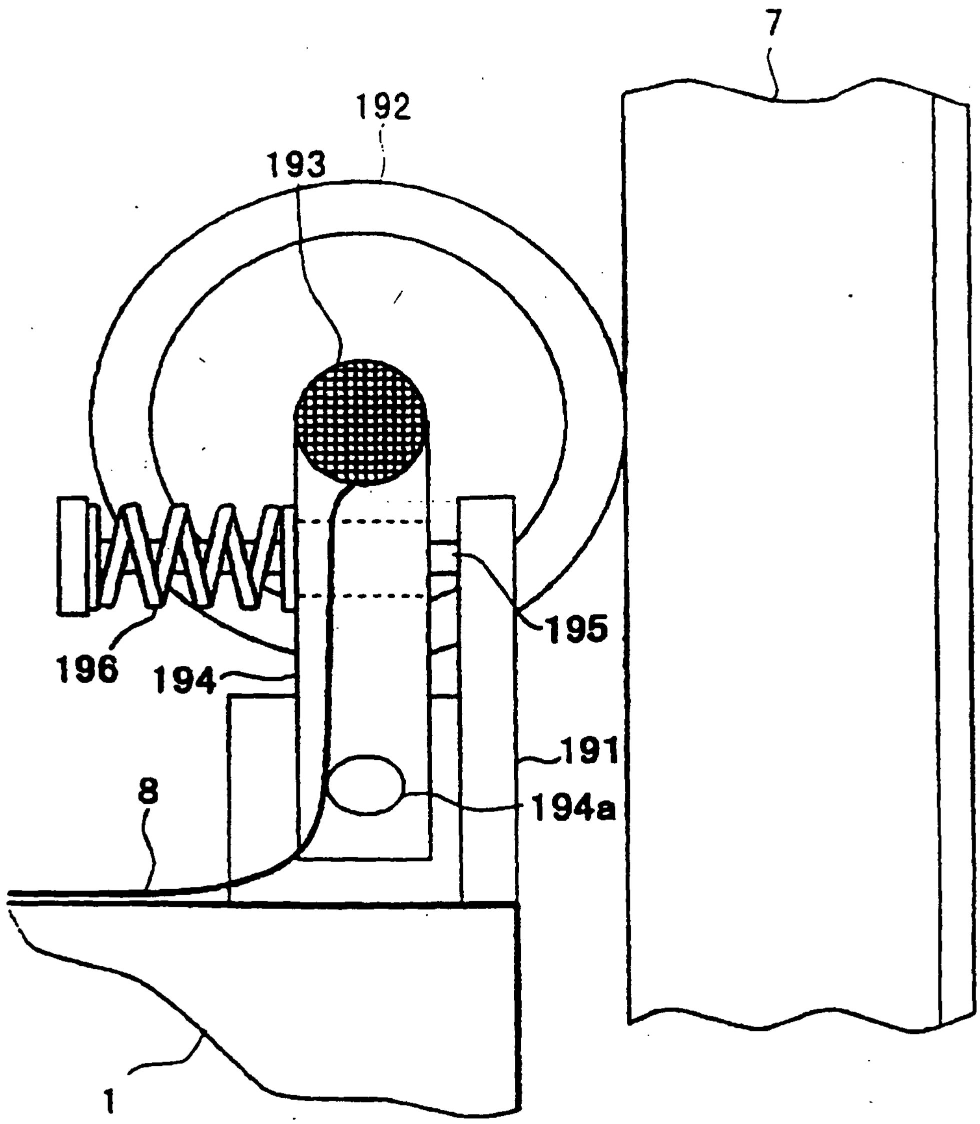

FIG. 7

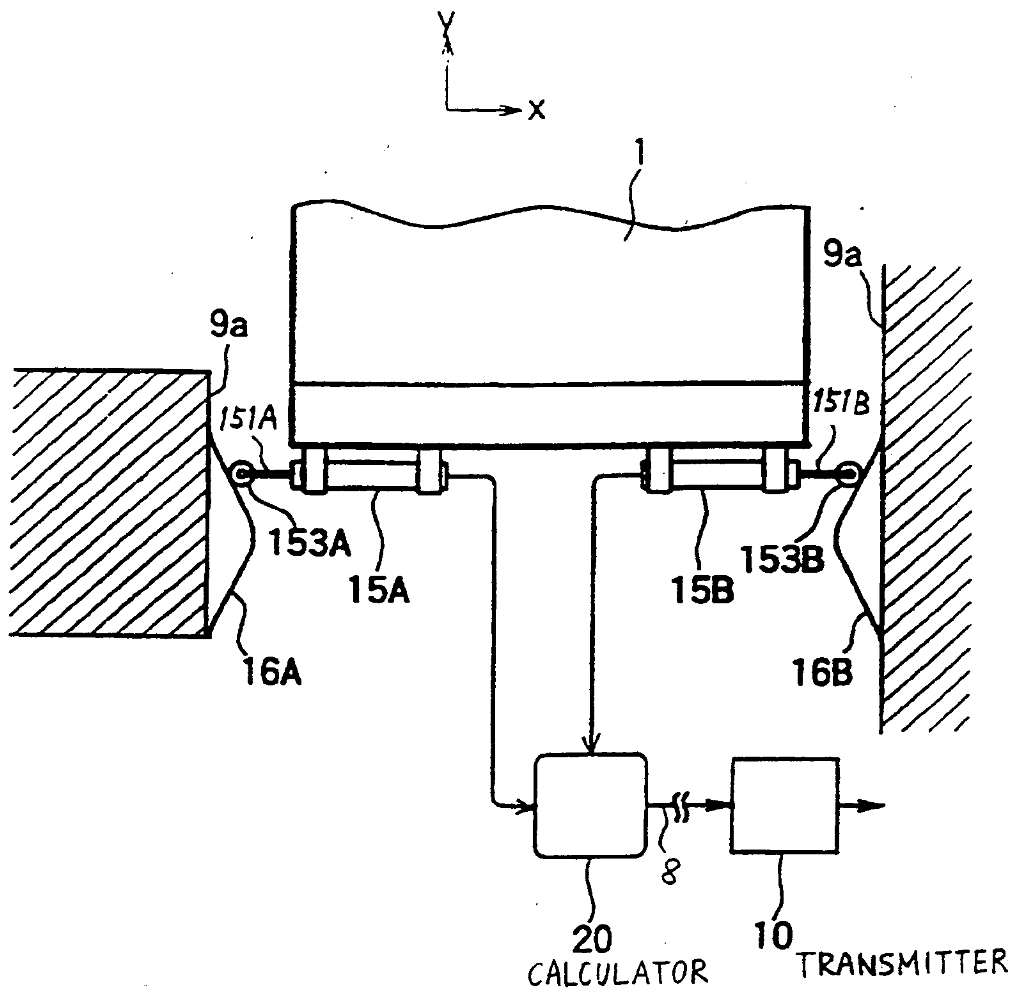
Y
X
1
9a
9a
151A
151B
153A
15A
15B
153B
16A
16B
8
20
CALCULATOR
10
TRANSMITTER

FIG. 8

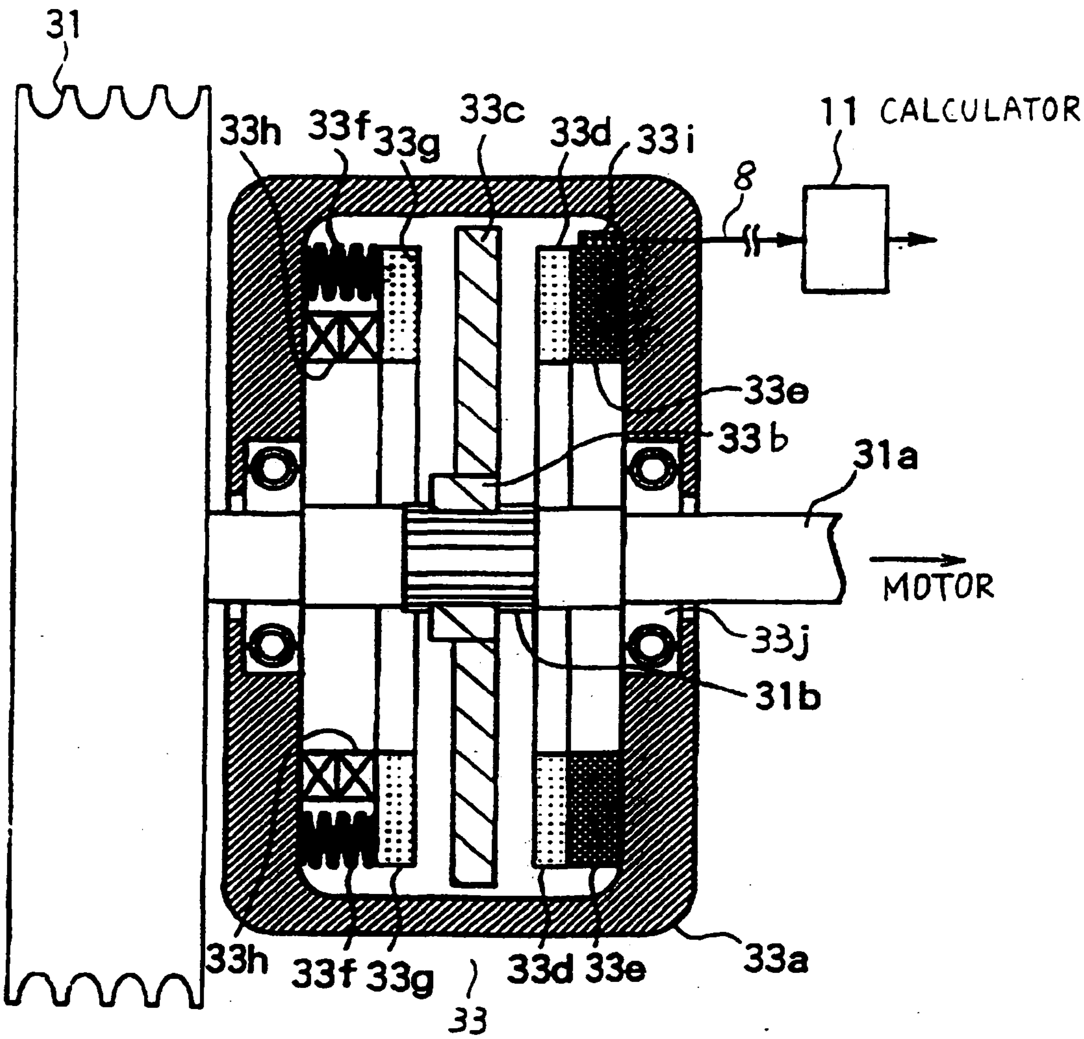
31
33h
33f
33g
33c
33d
33i
8
11 CALCULATOR
33e
33b
31a
MOTOR
33j
31b
33h
33f
33g
33d
33e
33a
33

FIG. 9

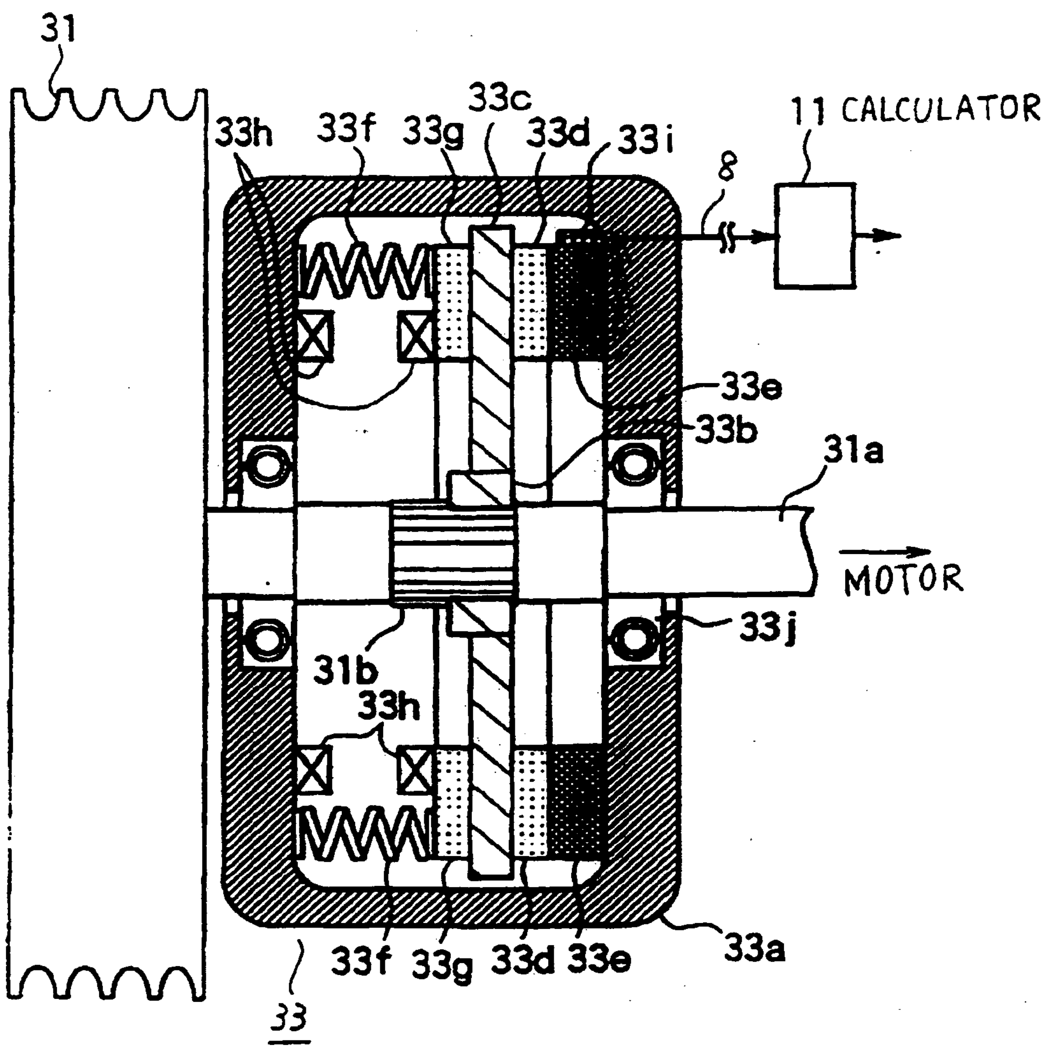
31
33h
33f
33g
33c
33d
33i
8
11 CALCULATOR
33e
33b
31a
MOTOR
33j
31b
33h
33f
33g
33d
33e
33a
33

FIG. 10

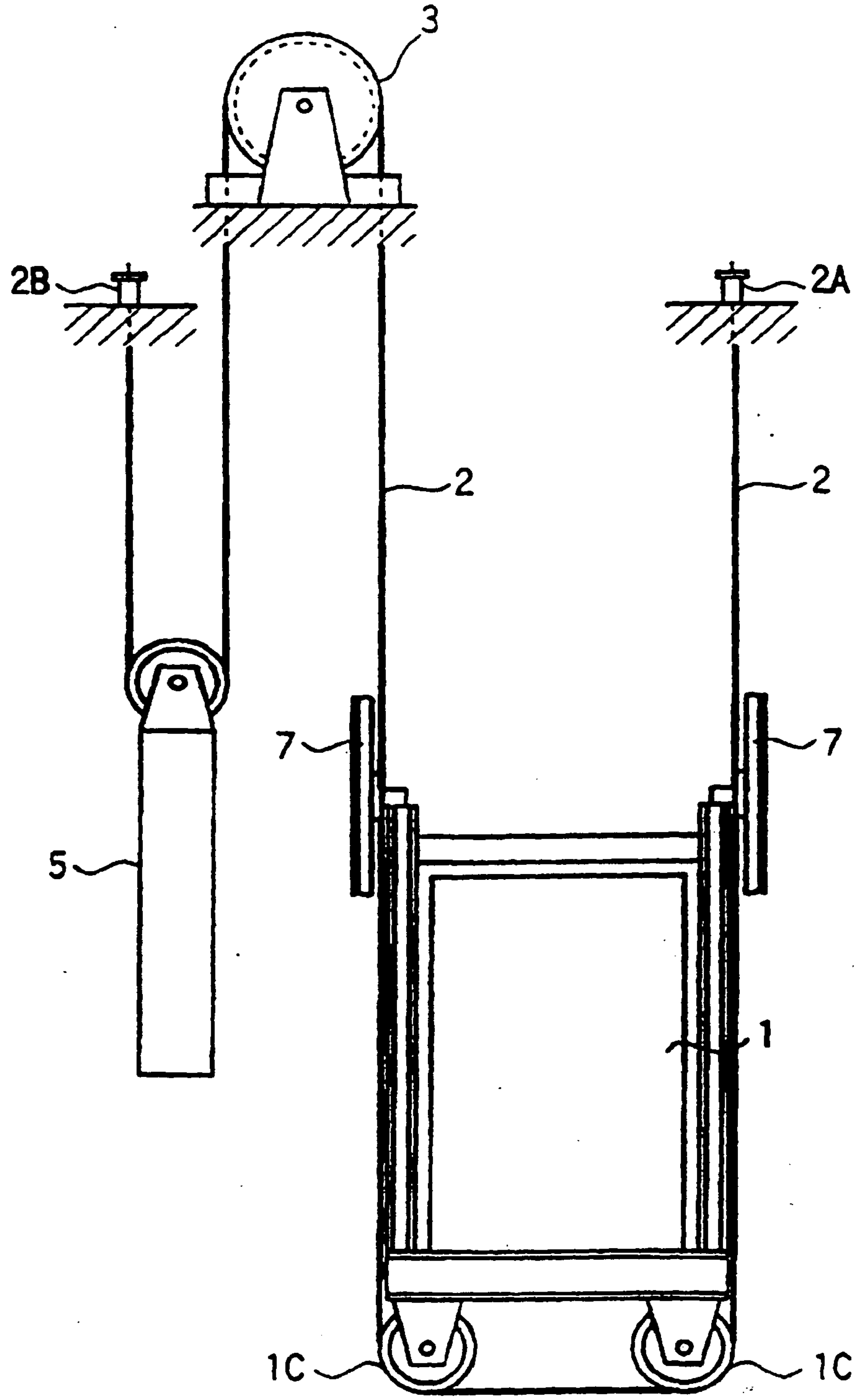

FIG. 11

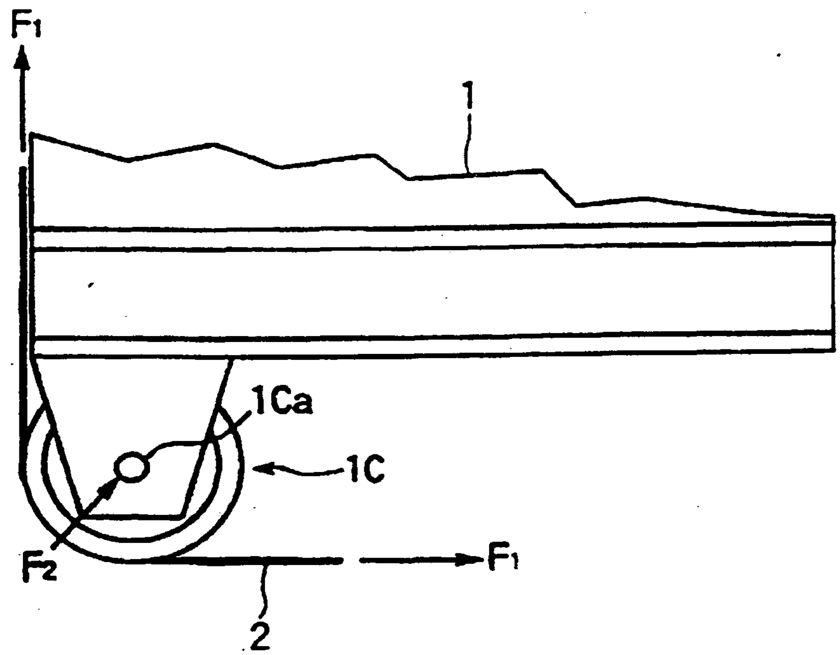

FIG. 12

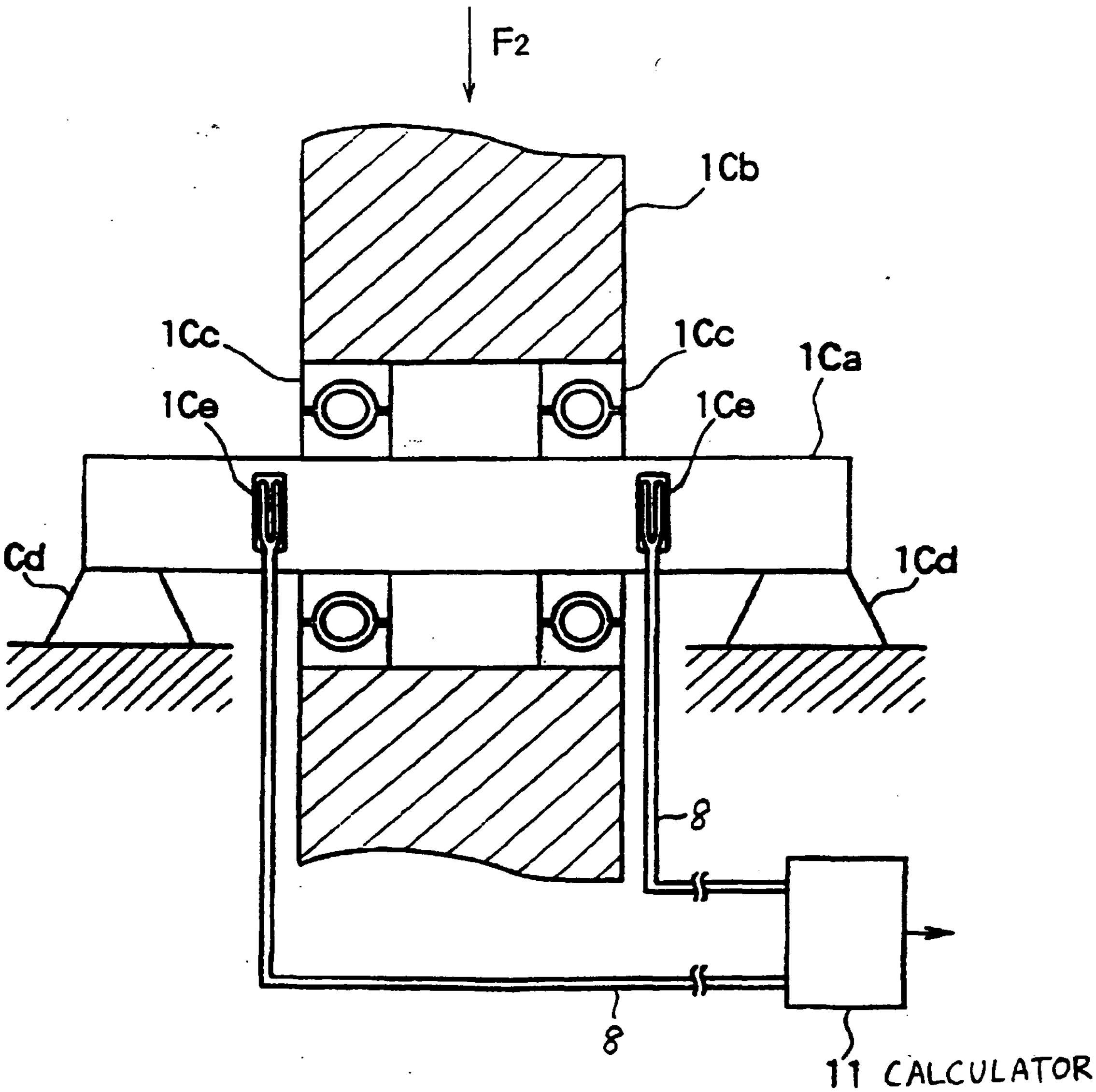

FIG. 13

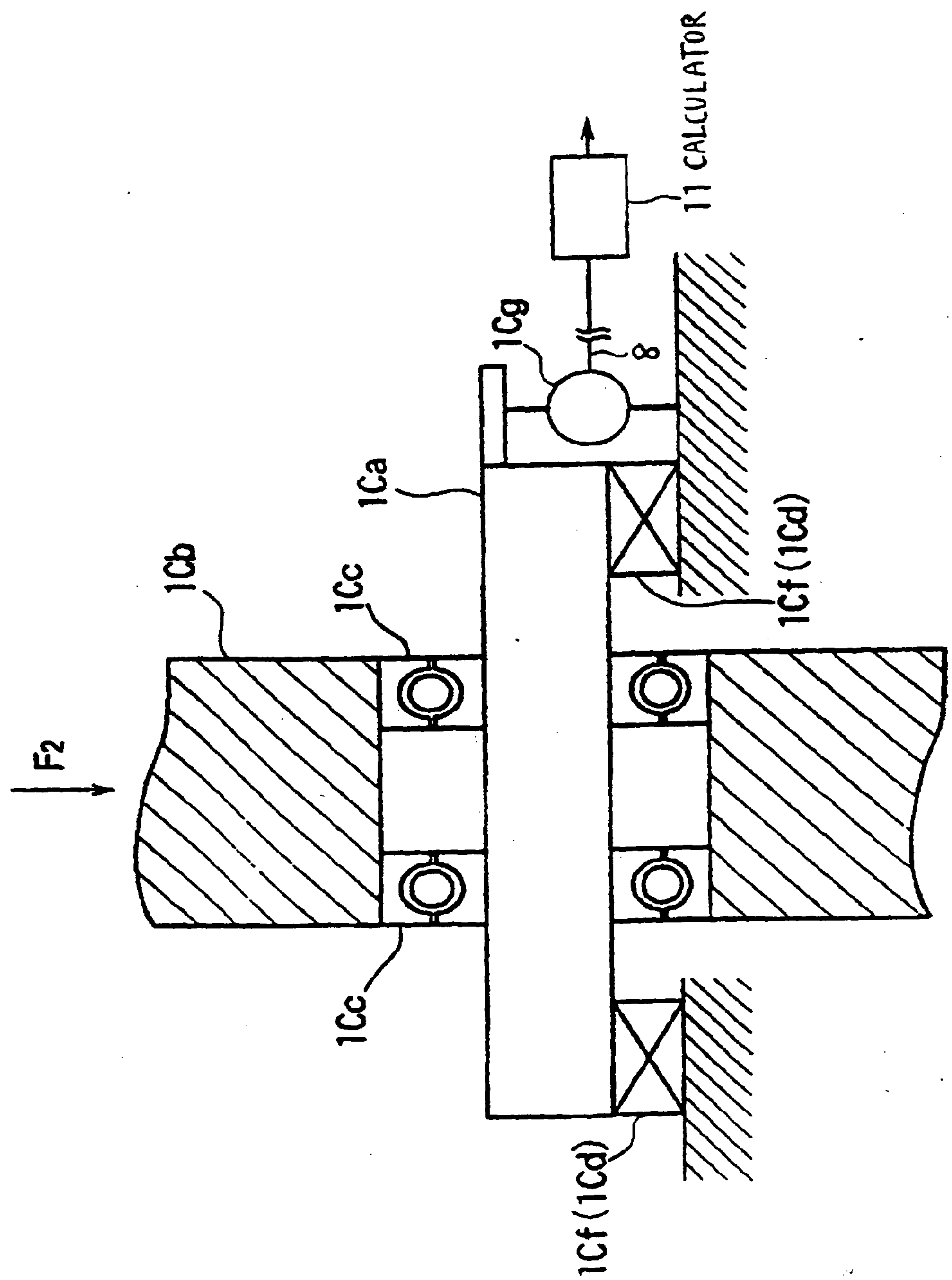

FIG. 14

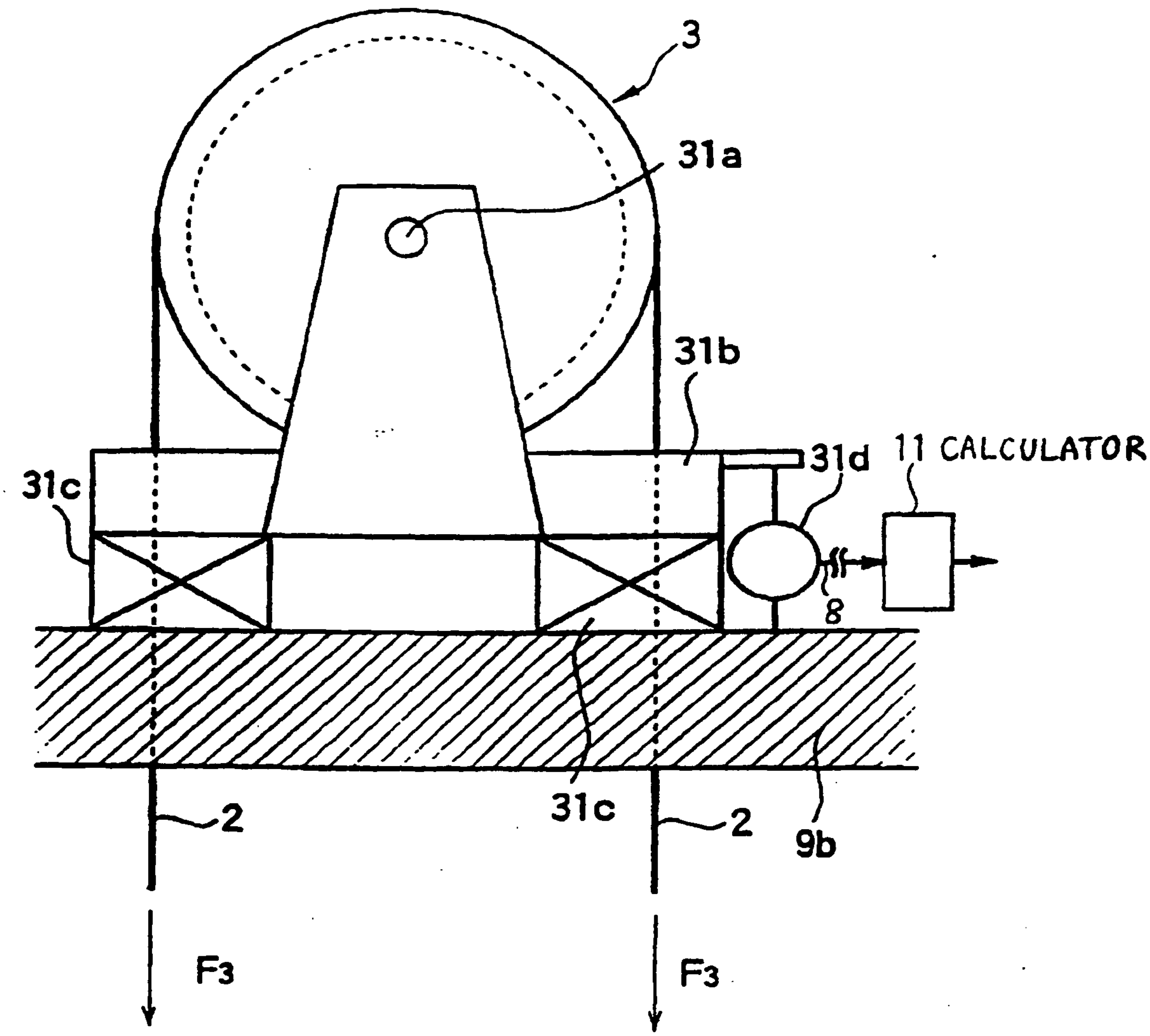

FIG. 15